

THE GEORGE WASHINGTON UNIVERSITY
NAVY GRADUATE COMPTROLLERSHIP PROGRAM

AN INVESTIGATION OF THE FEASIBILITY OF A STATISTICAL APPROACH
TO THE DEOBLIGATION OF FUNDS UNDER TERMINATED CONTRACTS

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PREPARED FOR
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INTRODUCTION

General

The comptroller was established in the national military establishment by the National Security Act Amendments of 1949.¹ With the passage of these amendments, it became clear that Congress was demanding more efficient financial management of the armed services. If the belief is held that perfection should always be strived for, even though it is seldom, if ever, attained, practically the entire field of financial management is thrown open for study. One such area which has captured the author's imagination is the deobligation of funds on terminated contracts.

Studies made by the various bureaus within the Navy and the Navy Department as a whole show that the costs involved in the settlement of terminated contracts are, on the average, substantially less than the value of the items terminated. Thus, the problem becomes one of determining the costs of termination, with any funds in excess of this amount being deobligated at the earliest practical moment. A true determination of this amount must wait until a settlement agreement has been executed. The steps to settlement are many. Months, often years pass before it is accomplished. Obviously, an estimating procedure must be used.

The present estimating procedures for this purpose leave room for improvement. The estimates of costs arising from a given termination are inaccurate; the time required to obtain this estimate is excessive and reviews of the

¹ 81st Congress, 1st Session, Public Law 216, August 10, 1949.

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The first of the two main parts of the book is devoted to a discussion of the various methods of determining the relative positions of the stars. This part is divided into two sections, the first of which deals with the determination of the positions of the stars by means of the method of triangulation, and the second with the determination of the positions of the stars by means of the method of parallax. The second part of the book is devoted to a discussion of the various methods of determining the absolute positions of the stars. This part is divided into two sections, the first of which deals with the determination of the absolute positions of the stars by means of the method of parallax, and the second with the determination of the absolute positions of the stars by means of the method of proper motion.

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original estimate are few and far between. While this is not a desirable situation, it is tolerated for reasons to be brought out later.

It is the purpose of this paper to explore, in part, the feasibility of a statistical approach to the deobligation of funds under terminated contracts. The goal strived for was a multivariate correlation of available factors, which would permit, within limits, the prompt and accurate deobligation of funds estimated to be in excess of costs resulting from the termination. A secondary application for management would be in making a decision as to what contracts could and should be terminated if additional funds are required, and the only source of funds, however devious it may be, is by means of terminating current contracts. In this area it would prevent the termination of an excessive number of contracts in order to meet the need for additional funds.

While the extent of this condition is unknown and, therefore, can only be estimated, it obviously means the Navy has greater obligational authority than needed. It is the author's opinion that improved financial management in this area would ultimately lead to a reduction in the new obligational authority annually requested from Congress.

The results of an earlier study which was limited to a linear correlation, gave promise of fruitful results with the application of other factors.²

Scope of Study

As in the case of the earlier study certain limitations on the extent or scope of the study were necessary.³ Because it would have been impossible to gather adequate data for the entire Navy within the time available, the study

²Fred C. Timm, "An Analysis of the Correlation Between Termination Costs and the Value of Items Terminated" (term paper for a course in Comptrollership Statistics, The George Washington University, January 9, 1959), pp. 6-7.

³Ibid., pp. 2-3

was limited to Bureau of Aeronautics contracts. This bureau has accounted for a substantial portion of both the terminations in any given period and the backlog of unsettled termination claims. For example, during the period from 1 July 1958 through 31 December 1958 this bureau terminated contracts valued at \$124,323,000 or 44% of all Navy terminations. The backlog on 31 December 1958 was \$776,736,000 or 82% of the total Navy backlog.⁴ It is, therefore, reasonable to assume that productive results for this bureau would at least be partially applicable in other bureaus and offices of the Navy Department.

The study was further limited to fixed-price type contracts, and letter contracts scheduled for conversion to fixed-price type contracts. Cost type contracts were eliminated from consideration due to a difference in handling termination costs. For this type contract the settlement is generally limited to an adjustment of the fee, if a fee is involved. The costs incurred for the terminated work are, for the purposes of this study, hidden in other records. On the other hand, settlement costs for the terminated contracts included in this study show all costs, including any profit. While the Navy is permitted the use of other contract types, their use is minor, particularly in the Bureau of Aeronautics.⁵ During the six months period ending 31 December 1958, they accounted for only 1% of the net Navy procurement.⁶

The government can terminate contracts for convenience or for default. Termination for convenience places an obligation on the government to pay the

⁴U. S. Department of the Navy. Survey of Procurement Statistics, NavExos P-1753, Office of Naval Material, December 1958, p. 8. Cited hereafter as Survey of Procurement Statistics.

⁵For a complete description of authorized contract types, including their applicability and limitations on their use, refer to U. S. Department of Defense. Armed Services Procurement Regulation (Washington: Government Printing Office, 1955). Cited hereafter as ASPR.

⁶Survey of Procurement Statistics, loc. cit., p. 25.

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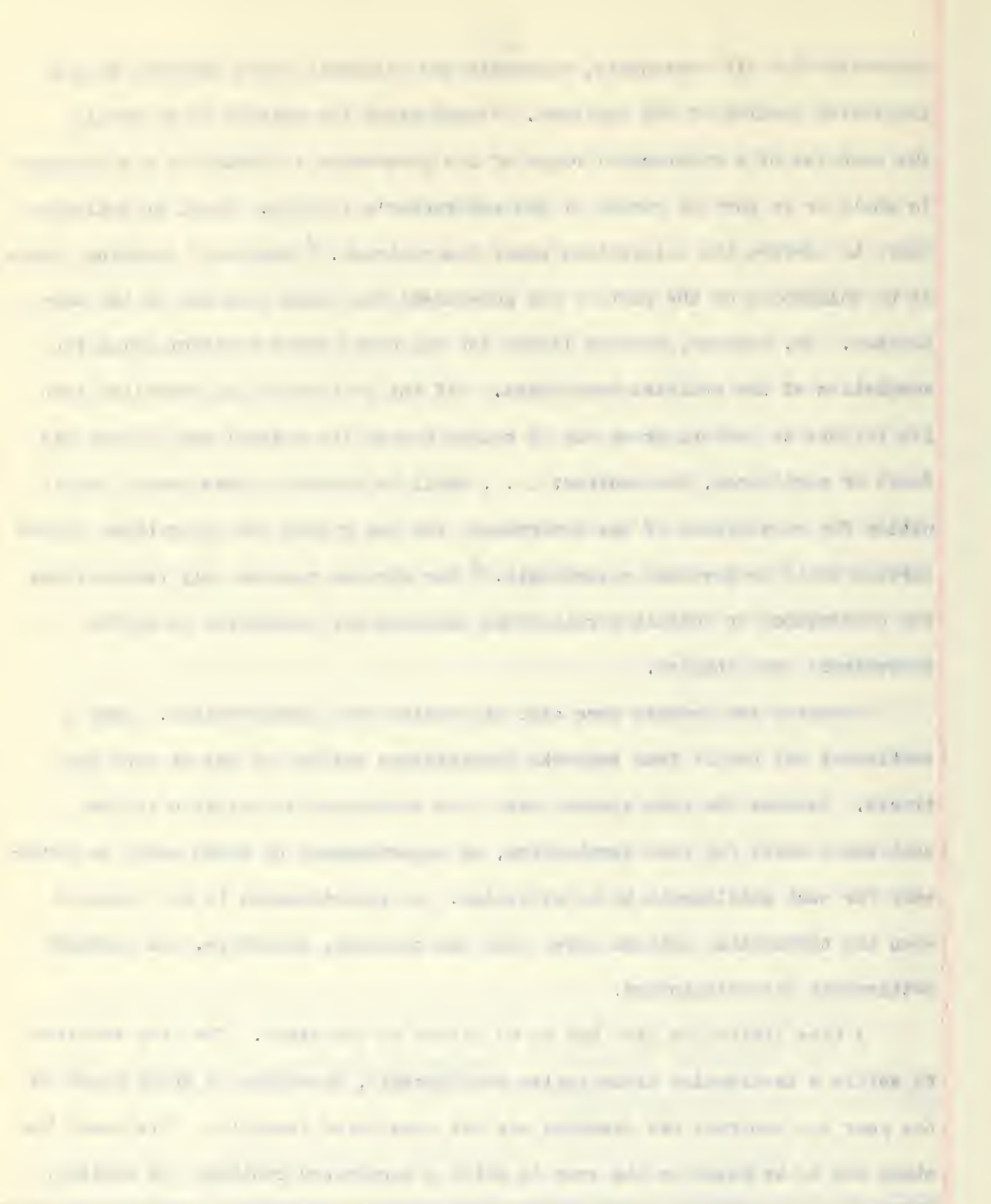
contractor for all reasonable, allocable and allowable costs incurred on the terminated portion of the contract. "Termination for default is generally the exercise of a contractual right of the government to terminate the contract in whole or in part by reason of the contractor's failure, actual or anticipatory, to perform its obligations under the contract."⁷ Generally speaking, there is no obligation on the part of the government for costs incurred by the contractor. He, however, becomes liable for any costs above contract price for completion of the articles terminated. "If the contractor can establish that its failure to perform arose out of causes beyond its control and without its fault or negligence, the contract . . . shall be deemed to have been a termination for convenience of the Government, and the rights and obligations of the parties shall be governed accordingly."⁸ For obvious reasons only terminations for convenience or default terminations subsequently considered to be for convenience were studied.

Combined settlements were also eliminated from consideration. Such a settlement may result from separate terminations actions on one or more contracts. Because the time element was to be considered in relation to the settlement costs for each termination, an apportionment of costs would be necessary for such settlements to be evaluated. An apportionment is not required when the termination actions cover only one contract, therefore, all combined settlements were eliminated.

A time limitation also had to be placed on the study. The time required to settle a termination claim varies considerably, therefore, a study based on the year the contract was executed was not considered feasible. This meant the study had to be based on the year in which a terminated contract was settled.

⁷ ASPR, loc. cit., art. 8-601(a), p. 853.

⁸ ASPR, loc. cit., art. 8-601(b), p. 853.



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To insure a study of adequate size, all final settlements made during the period from 1 January 1955 through 31 December 1958 were considered.

In summary then, this study was limited to final settlements of those fixed-price type contracts let by the Bureau of Aeronautics which were terminated for convenience of the government and which were settled during calendar years 1955 through 1958.

One assumption had to be made with respect to the regulations governing contract terminations. During calendar years 1955 to 1958 there have been numerous minor changes in those portions of procurement regulations governing contract terminations. No major changes in overall concept were made. It is therefore believed a valid assumption, that these minor changes created no effect on this study or the contract termination program itself, therefore they have not been considered herein.

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CHAPTER I

CONTRACT TERMINATIONS

In order to obtain a feel for the problem, an understanding of contract termination procedures is necessary. It is hoped that such an understanding will be created by the following pages of this chapter.

Legal Principles and Regulations

In the business world of today it is a recognized principle of law that neither party to a contract may, at his own discretion, decide that he no longer needs the materials or services contracted for. How then is it, that the armed services are able to terminate contracts for the convenience of the government? The cornerstone for present day termination regulations was laid many years ago in 1876, by the Supreme Court decision in the now famous Corliss Steam-Engine Company case.¹ In part the decision of the court said:

Contracts for the armament and equipment of vessels of war may, and generally do, require numerous modifications in the progress of the work, where that work requires years for its completion. With the improvements constantly made in shipbuilding and steam machinery and in arms, some parts originally contracted for may have to be abandoned, and other parts substituted; and it would be of serious detriment to the public service if the power of the head of the Navy Department did not extend to providing for all such possible contingencies by modification or suspension of the contracts, and settlement with contractors.²

¹United States v. Corliss Steam-Engine Co., 91 U.S. 321, 322, 323 (1876). Cited from a proposed revision to Navy Contract Law, NavPers 10841, prepared by Albert Green, Office of General Counsel, Department of the Navy. Hereafter, the proposed revision is cited as Navy Contract Law.

²Ibid. Cited from Navy Contract Law, p. 13.

"As a result of the Corliss decision, the authority of contracting agencies to terminate contracts and settle the attendant claims became well recognized. The Corliss decision has never been modified or overruled by the Supreme Court."³ From the date of this decision until early 1948 numerous measures on the termination of contracts were passed by Congress, but their application was limited to periods during and just after wars. On 19 February 1948 the Armed Services Procurement Act became law.⁴ This was the first permanent peace-time legislation which contained procedures for termination of contracts. On 19 May 1949 the Department of Defense implementation of this act became effective. It is titled "The Armed Services Procurement Regulation" although it is more commonly known and referred to as "ASPR". The publication of the provisions applicable to terminated contracts, and the settlement of claims arising from termination were delayed until January 1952. These provisions are now found in chapter 8 of ASPR.

For reasons due primarily to its' organizational structure, each service has its own implementation of the ASPR. For procedures within the Navy Department, the basic manual is the Material Inspection Service, USN, Administration Manual. Chapter 10 of Volume 2 concerns contract terminations.⁵

Present Termination Procedures

Once a decision has been made to terminate a given contract, it is customary to send the contractor a telegraphic notice of termination, followed by a registered letter. Both state the type of termination, either for convenience or default; the effective date; the extent of termination and any special

³Navy Contract Law, p. 13.

⁴80th Congress, 2nd Session, Public Law 413, February 19, 1948.

⁵U.S. Department of the Navy, Office of Naval Material Instruction 5000.3, August 8, 1957. Cited hereafter as Administration Manual.

instructions. In most cases the only special instruction is a request that the contractor inform the contracting officer in fifteen days of estimated funds necessary to effect complete settlement of the termination. A sentence usually included in the notice states that the estimate is in no way binding on the contractor or the government. In spite of this, most contractors submit estimates on the high side.

After receipt of the notice, the contractor must send similar notices to his first tier subcontractors, who in turn must terminate their immediate subcontractors, etc., until the lowest tier subcontractor has been terminated. If the termination is for only part of the contract, the contractor must first determine what orders are needed for the continuing portion of the contract. On large contracts, it is easy to visualize the problems involved in making such a determination.

If costs will be involved in the settlement, the contractor must prepare certain forms required by ASPR. The most important are the Settlement Proposal and the Inventory Schedules. Three major steps usually must be taken before the settlement proposal may be brought before the contracting officer for negotiation of the final settlement. First, the inventory must be disposed of in accordance with governing regulations. While there are many ways to effect disposal, the largest part of all termination inventory is sold as scrap.⁶

Secondly, all subcontractor terminations claims applicable to this termination must be settled. To expedite this process, the contractor is now authorized to conclude settlements of \$10,000 or less of his terminated subcontracts, provided the contracting officer is satisfied with the procedures used by the contractor. Claims in excess of this amount are approved by the cognizant inspection office.

⁶For details on methods of disposal, see ASPR, chap. 8, pt. 5, pp. 839-52.

The third step is required only when the proposed settlement is in excess of \$1,000. This being the case, the cognizant military audit office must audit the settlement proposal. This may be either a field or an office audit depending on the circumstances. Generally the latter is processed more expeditiously.

After the contracting officer and the contractor have come to an agreement, a settlement agreement is executed. However, if the agreement, as negotiated, exceeds \$25,000, it must pass the scrutiny of a Settlement Review Board prior to execution.

This, in a capsule version, is the basic procedure followed in the settlement of termination claims. Perhaps it has been set forth too briefly or too simply. It would seem that few problems would arise which would delay the settlement of termination claims.

Problem Areas

Basically, the problem areas may all be boiled down to one factor - time. To illustrate just how much time is involved a review was made of all settlements, including combined settlements, made during one fiscal quarter. The results are shown in Table 1.

TABLE 1

TIME REQUIRED TO EFFECT SETTLEMENT OF TERMINATED CONTRACTS

Settlements	Number settled during quarter	Months from termination to settlement		
		High	Average	Low
Without cost	13	49	14	Less than 1
With cost	22	64	36	14
All	35	64	28	Less than 1

To give more meaning to this, there should be some information on the dollars involved. On those settlements made without cost; the total value for

all items terminated was \$43,410,000, for the settlement requiring the longest time, the items terminated were valued at \$11,211,000 while the most expeditious settlement involved only \$2,000.

The settlements with cost have a total value of items terminated of \$66,623,000, the slowest settlement involved \$645,624 and the fastest, \$3,159. While this data was obtained from only one fiscal quarter, it is believed that it is fairly representative of the situation existing at any given time.

While each termination presents problems of its own, some of which preclude early settlement, there are some relatively common reasons which help to explain the delay in effecting settlement. Without any doubt, the element which consumes the most time is the disposal of inventory, both at the prime contractor and subcontractor levels. Excluding claims of less than \$1,000, inventory must be classified as: (1) Metals in Mill Product Form, (2) Raw Materials other than Metals, (3) Purchased Parts, (4) Finished Components, (5) Finished Products, (6) Miscellaneous, (7) Work in Process, (8) Dies, Jigs, Fixtures, etc., and Special Tools. In addition:

Separate schedules shall be prepared to list contractor-owned property and Government property in the categories listed below. Classification of property under each of the following categories shall be subject to the approval of the Inspector:

- (a) Each commodity group of production equipment.
- (b) Serviceable aircraft or aircraft components.
- (c) Serviceable or usable material other than (a) or (b).
- (d) Inventory considered to have only a scrap or salvage value.

In addition to the foregoing, separate schedules shall be submitted for property at each location.⁷

On completion of this horrendous task, the inventory must be screened for possible use. Various types of inventory must be screened by different offices or agencies and for varying lengths of time.

Remembering that this process must be accomplished for not only the prime

⁷ Administration Manual, loc. cit., art. 211101(c)2, p. 11-6.

contractor but all subcontractors submitting claims, it is obvious why the settlement of termination claims involving costs takes so long. In settling claims which do not involve cost, the disposal of inventory cannot be considered a problem because the contractor keeps it for his own use. It often happens that a contractor may have originally planned to submit a claim, but other contracts for the same item developed subsequent to the termination. In this case, he may be able to divert all inventory to the new work, thereby permitting a no cost settlement for the original termination.

As hinted above, the settlement of subcontractor claims is a second built-in delay factor. Of course, it will vary with the subcontracting structure involved on the termination in question. Generally, the structure is primarily horizontal but in a large contract such as for airframes, the depth of the structure cannot be overlooked. It is not uncommon for this structure to extend four or five levels below the prime contractor.

A subcontractor at any given level must settle all claims of his subcontractors before he can submit his settlement proposal to the next higher level. A delay in the settlement of just one lower tier subcontractor can thereby tie up the settlement of the contractor's claim and all claims of subcontractors in this particular chain. There are ways to alleviate this condition; however, they are seldom used because of the legal entanglements.

The audit requirements for subcontractor claims over \$25,000 and all prime contractor claims over \$1,000 are a third built-in delay factor. In the author's experience as a member of a Settlement Review Board for subcontractor claims, it was not uncommon for the elapsed time from the request for audit until completion, to be in excess of six months. Perhaps one very valid reason for this is the emphasis on the audit of current procurement to the detriment of the termination claims. This, of course, only makes the audit more difficult when it is begun.

These three factors; disposal of inventory, settlement of subcontractor claims, and the audit, are the most important reasons for the delay in settlement. The delay in settlement in turn, delays the final deobligation of funds under the terminated contract.

CHAPTER II

DEOBLIGATION OF FUNDS

Present Procedures

In the introduction it was pointed out that the deobligation of excess funds was based on estimates. In Chapter I, it was shown that estimates were necessary because of the excessive amount of time between the date of termination and the execution of the settlement agreement. This deobligation is normally based on the contractor's estimate of funds necessary to effect complete settlement of charges arising from the termination.

The contractor's letter is normally forwarded via the cognizant inspector for his comment and recommendation. In any event, the cognizant inspector must "determine whether the contractor will accept a no-cost settlement agreement, or whether a settlement proposal will be submitted."¹ "If a settlement proposal is to be submitted, the notice to the contracting officer shall include the contractor's best estimate of the amount of the proposal and the contemplated date of filling such proposal."² This step is usually accomplished by an endorsement to the contractor's letter.

The decision on total funds to be deobligated is based on the estimate submitted by the contractor, the comments of the cognizant inspector, and the judgment of the contracting officer. As a general rule, the amounts deobligated

¹Administration Manual, loc. cit., Vol. 2, art. 210100(b)2(c), p. 10-5.

²Ibid., art. 210100(c)3, p. 10-5.

are in agreement with the difference between the contract value of the items terminated and the contractor's estimate of funds required for settlement of the termination claim.

The contracting officer then forwards a letter to the Navy Regional Accounts Office charged with the accounting for the particular contract. For this purpose the Bureau of Aeronautics has a form letter, the meat of which states, "based on the best evidence available, it is estimated that settlement costs, including termination charges, will approximate \$_____." This is the document on which the Navy Regional Accounts Office deobligates excess funds.

This initial deobligation of funds is not necessarily the only deobligation until final settlement is made. It is the responsibility of the inspector to periodically review the contractor's progress in processing the termination claim. During such review, if the inspector determines that the funds required to cover the termination charges are substantially different from the latest estimate, he is expected to notify the contracting officer. The contracting officer then deobligates additional funds, or in some cases, increases the obligation to cover the termination charges.

After execution of the amendment covering all termination charges, the cognizant Navy Regional Accounts Office, on the basis of a copy of the amendment, deobligates or obligates funds as necessary to bring the contract account records up to date.

Weaknesses

In the author's opinion, there are three fundamental weaknesses in this system not conducive to good financial management. In order of discussion, they are the error in the estimates of funds to cover termination costs, the time required to make the initial deobligation of funds, and the inadequacy of reviews of original or subsequent estimates. However, before discussion on

these points, the reader should have an idea of the dollars involved in terminations. Table II provides that information for a two and one half year period.

TABLE II

CONTRACT TERMINATIONS AND BACKLOG OF UNSETTLED CLAIMS

Fiscal Year	Terminations				Backlog of Unsettled Claims			
	Navy		Bu Aer		Navy		Bu Aer	
	No.	Amount ^a in thousands	No.	Amount ^a in thousands	No.	Amount ^a in thousands	No.	Amount ^a in thousands
1957	824	459,577	175	395,922	706	1,166.257	218	1,003,738
1958	748	284,789	146	187,008	672	778,445	198	623,703
1959 ^b	759	281,305	66	224,915	612	935,706	177	776,736

^aContract Price of Items Terminated

^bFirst six months only

At the insistence of Congress, the Navy, as well as the other services, has been reducing the backlog of unsettled claims. The all-time high for backlog was reached in November 1954, just after the Korean armistice. For the Navy alone, the backlog, based on the contract price of the items terminated, was 2.58 billion dollars.

It is almost impossible to determine the extent of excess funds at any given time due to the varying time period required for settlement. To determine this, it would be necessary to examine the status of every unsettled terminated contract as of a given date. The funds obligated as of that date as compared with the funds required for settlement would no doubt prove most interesting. The total of the excess funds would not necessarily be the result of estimating errors. As pointed out earlier, settlements originally involving considerable costs may result in no-cost settlements if the contractor is able to divert all inventory. In addition, there are reinstatements of terminated contracts which

TABLE 1. SUMMARY OF THE DATA FOR THE STUDY

Year	1990		1991		1992		Total
	Male	Female	Male	Female	Male	Female	
Age (years)	15-24	15-24	15-24	15-24	15-24	15-24	
Occupation	Student	Student	Student	Student	Student	Student	
Marital status	Single	Single	Single	Single	Single	Single	
Religion	Muslim	Muslim	Muslim	Muslim	Muslim	Muslim	
Ethnicity	Malay	Malay	Malay	Malay	Malay	Malay	

Source: Data from the study.

Notes: The sample size was 1000.

It is the first time that a study of this kind has been conducted in the country.

The study was conducted in the city of Kuala Lumpur, which is the capital of the country.

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also would have a bearing on this figure.

Some years ago it was estimated by an now unknown person that the Bureau of Aeronautics average obligations on terminated contracts were 17% of the contract value of the items terminated. This does not compare favorably with the average of actual settlement costs. "Over the past thirteen years settlements on fixed price contracts have averaged approximately ten cents per dollar on the contract price terminated. This figure includes both cost and no-cost settlements."³ If it is assumed that the seven percent overage still exists, the Bureau of Aeronautics, like the man who lost the combination to his safe, has \$54,000,000 locked up, but there is no way to get to it at present. To say that the actual situation is of this magnitude would be entirely speculative and without foundation. However, some indications to be brought out later will give a hint - and only a hint - of what does exist.

In Chapter I, mention was made of the request that the contractor submit an estimate of settlement costs within fifteen days of termination. After numerous discussions with termination personnel, the author is inclined to believe that this estimate is rarely received within the specified time limit. Because time did not permit a survey on this subject, it seemed reasonable to assume that personnel working in this field could supply a rough estimate. The consensus of opinion was that the first estimate was received between two and four months after termination, on the average.

Such a condition delays the initial deobligation of funds. As inaccurate as the estimate may be it still results in making funds available for reobligation. During a period of rising costs, any delay in obligating funds becomes costly. This has been particularly true of military procurement in the last few years.

³Interview with Carl Clark, Office of Naval Material, Chairman of ASPR sub-committee on Terminations, 27 March 1959.

The Inspector's follow-up review on the status of a termination claim will often bring to light a substantial difference in the original estimate and the latest information available from the contractor. Corrective action, by means of a revised estimate, should be undertaken immediately. Unfortunately, this is not often done.

The following is an example of the estimating error, the time required to obtain the original estimate, and the lack of adequate review: There were two terminations on one contract within an eight month period, with the total value of items terminated approximating 41.2 million dollars. The initial deobligation of funds for the first termination occurred nine months after termination, and for the second, three months after termination. At this point, eleven months after the first termination, the total estimated settlement costs for the two terminations was 9 million dollars. Eighteen months later additional funds in the amount of 7 million dollars were deobligated which meant that settlement costs were now estimated to be 2 million dollars. In this particular case, there were no apparent extenuating circumstances such as diversion of materials or reinstatement which could account for the significant decrease in the estimated amount of the claim. It is believed that this claim has not yet been settled, therefore, the actual costs arising from these claims are unknown.

Dollarwise, the smaller terminated contracts are not very significant but the errors still exist. One contract was originally expected to result in settlement costs of \$15,000. Recently the estimate was revised downward to \$2,700. These two examples are admittedly among the more serious but they are brought out to show that the continued obligation of funds in excess of settlement charges is a fact. As pointed out earlier, the extent is unknown but evidence points to it being a substantial amount of money.

To summarize briefly, the present procedures are inadequate. The estimates are faulty, the time to obtain the estimates appears excessive and

reviews of original or subsequent estimates are probably inadequate. Considering the amounts of money which seem to be involved, the need for more effective control is manifest.

CHAPTER III

THE STATISTICAL APPROACH

Factors Affecting Settlements

Given the problem as it exists and a desire for a solution, perhaps the best approach would be to revise the regulations applicable to terminations so that settlements may be reached in a reasonable amount of time. This study, however, is limited to the existing procedures and the present organization; therefore, a study of the feasibility of a statistical approach.

If statistics are to be applied, the first question is what statistics. The answer is those statistics which will provide a reasonable estimate of what is a fair and just settlement. A fair and just settlement, as will be seen from the following quotation from ASPR, can be several different amounts of money, depending on the approach.

The primary objective in negotiating a settlement is to agree on an amount to compensate the contractor fairly and fully for the work done and the preparations made for the terminated portion of the contract, with such allowance for profit thereon as is reasonable under the circumstances.

Fair compensation for termination is inherently a matter of judgement and therefore cannot be measured exactly. In a given case, various methods may be equally appropriate for arriving at fair compensation; and differing amounts, resulting from reasonable variations of method and of sound judgement, may all be regarded as constituting fair compensation. The ability to apply standards of business judgement as distinct from strict accounting principles is at the heart of a negotiated settlement.

Cost and accounting data may provide guides for ascertaining fair compensation but are not rigid measures of it. Other types of data, criteria, or standards may furnish equally reliable guides to fair compensation.¹

¹ASPR, loc. cit., art. 8-301, p. 823.

THE REPORT

REPORT OF THE COMMISSIONER

REPORT OF THE COMMISSIONER

There are many things to be done in the way of improving the condition of the people of this State. The first thing to be done is to improve the condition of the people of this State. The second thing to be done is to improve the condition of the people of this State. The third thing to be done is to improve the condition of the people of this State. The fourth thing to be done is to improve the condition of the people of this State. The fifth thing to be done is to improve the condition of the people of this State. The sixth thing to be done is to improve the condition of the people of this State. The seventh thing to be done is to improve the condition of the people of this State. The eighth thing to be done is to improve the condition of the people of this State. The ninth thing to be done is to improve the condition of the people of this State. The tenth thing to be done is to improve the condition of the people of this State.

The report of the Commission is a very important one. It contains many suggestions for the improvement of the condition of the people of this State. The first suggestion is to improve the condition of the people of this State. The second suggestion is to improve the condition of the people of this State. The third suggestion is to improve the condition of the people of this State. The fourth suggestion is to improve the condition of the people of this State. The fifth suggestion is to improve the condition of the people of this State. The sixth suggestion is to improve the condition of the people of this State. The seventh suggestion is to improve the condition of the people of this State. The eighth suggestion is to improve the condition of the people of this State. The ninth suggestion is to improve the condition of the people of this State. The tenth suggestion is to improve the condition of the people of this State.

REPORT OF THE COMMISSIONER

The contracting officer, in order to arrive at a fair settlement with the contractor, should have certain knowledge about the termination in question. First of all he should have information about the product terminated. The following are some of the more important items he should know: (1) the complexity of the product, (2) the amount of research and development required, (3) the number of and the reasons for changes in the product, including those introduced by the contractor and the procuring agency, (4) the application of the product, to either military uses or both military and civilian uses.

The contracting officer should also be familiar with the overall operations of the contractor, and in particular, the operations under the terminated contract. Some measure of the efficiency of the contractor should be available as should information on the extent of the work actually accomplished by the contractor's manufacturing plant. The firm that does only final assembly work, as compared to the firm that manufactures the various components and assembles them as well, does not, as a general rule, deserve the same profit consideration as the latter company. The performance in meeting delivery schedules certainly provides a gauge of the contractor's efficiency.

A study must be made of the costs included in the settlement proposal in order to reach a good settlement. One method of studying the costs is on the basis of their reasonableness, their allowability and their allocability. The reasonableness of costs is self-explanatory. The allowability of costs is, and probably always will be, a problem area. ASPR recognizes this in that separate sections are devoted to cost which may be allowable and costs which should not be considered. The third item, allocability, concerns the assignment of costs. For example, a contractor engaged in both military and civilian work could not properly assign the president's salary only to the overhead charged against the military contract.

So much for the more common considerations involved in arriving at a just

settlement. Considering the fact that a statistical approach is to be studied, a determination is in order as to the various classifications of data available which may have a bearing on the settlement reached.

The first major classification is the dollar. Considering all Navy records maintained on a given contract, the following information is usually available:

(1) the original value of the contract, (2) the value of the contract at the time of termination, (3) the value of the items terminated, (4) the value of the items previously terminated, (5) the contract price for each item procured, (6) the amount allocated for spare parts, (7) the allocation of the total value of the contract by appropriation, (8) the cost of engineering changes.

The other major classification is time. In this area the more important items of information available are: (1) the time from execution of the contract to the termination in question, (2) the time from execution of the contract to delivery of the items terminated, (3) the manufacturing lead time.

Other factors which may show some relationship with settlement costs but which have no common measure are: (1) the type of item terminated, (2) the number of prior terminations, (3) the subcontracting structure, both horizontally and vertically, (4) the cost of living index.

The above enumeration of items should not be considered all inclusive. They were, in the author's estimation, the more important, and therefore, were thought to provide the most fertile grounds for the project undertaken.

Statistical Data Considered Applicable

Because of the unfirm ground on which this study was started, a review of the items mentioned above was necessary to determine those which showed the most promise of a significant relationship to settlement costs. At this point, the accessibility of the recorded data was given consideration. This reduced the items to those listed below. Following each item are the reasons why it was

felt it should be considered. Before the listing, however, a word of caution. The reasons given apply to that particular item when considered by itself. In other words it might be well to preface all reasons given with the statement, "Other things being equal." Further, the reasons given will not apply in all instances but will be valid in a majority of cases.

1. The original value of the contract. - The greater the original value in relation to the items terminated, the smaller the settlement claim is likely to be.

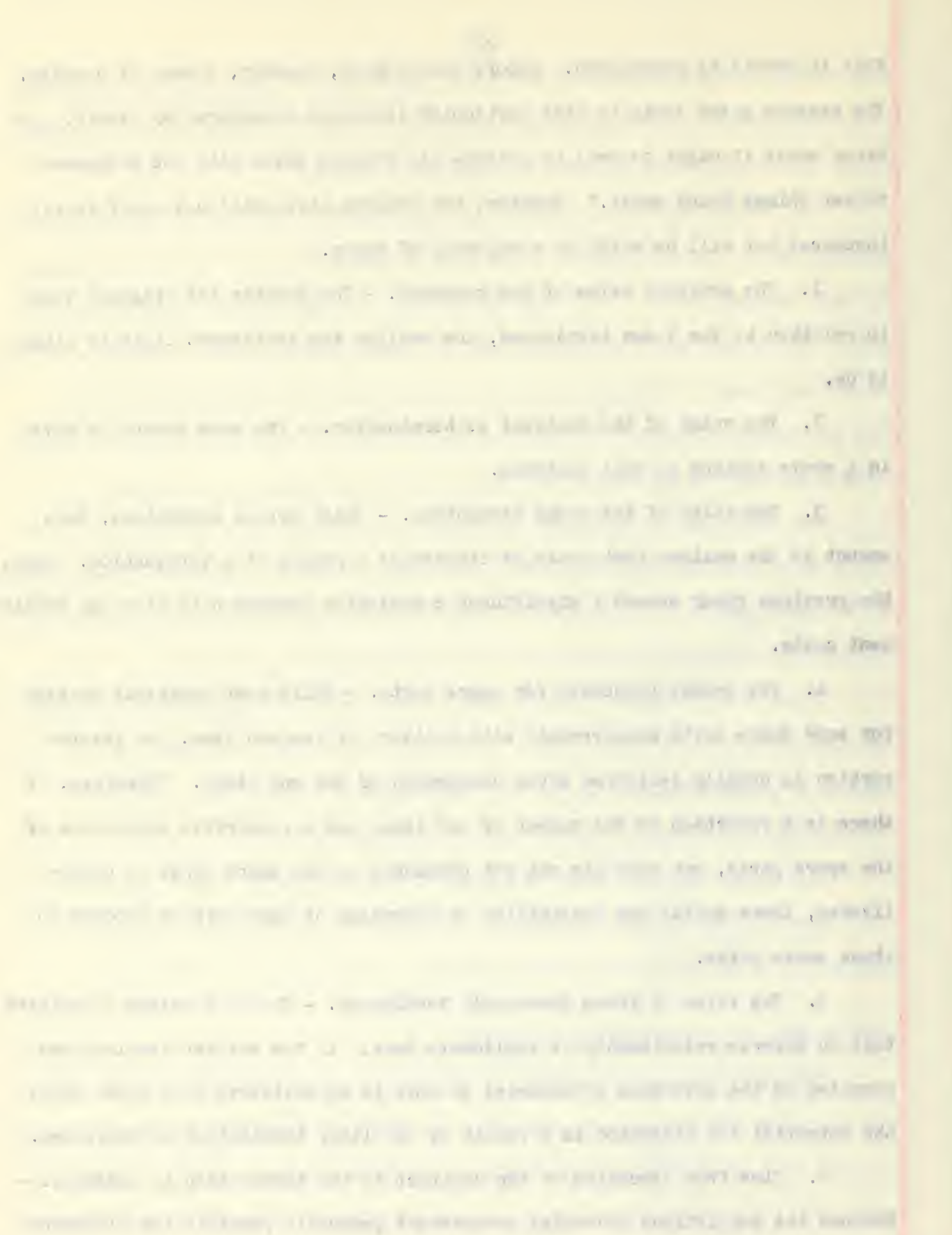
2. The value of the contract at termination. - The same theory as given in 1 above applies in this instance.

3. The value of the items terminated. - Under normal conditions, this amount is the maximum that could be claimed as a result of a termination. Also, the previous study showed a significant correlation between this item and settlement costs.

4. The amount allocated for spare parts. - While most contracts provide for some spare parts concurrently with delivery of the end item, the greater portion is usually delivered after completion of the end items. Therefore, if there is a reduction in the number of end items and a comparable proportion of the spare parts, but work has not yet commenced on the spare parts to be delivered, there exists the possibility of diversion of some work in process to these spare parts.

5. The value of items previously terminated. - There is reason to believe that an inverse relationship is applicable here. If the earlier terminations resulted in the diversion of material to work to be delivered at a later date, the potential for diversion as a result of the later termination is decreased.

6. Time from execution of the contract to the termination in question. - Because the regulations governing procurement generally prohibit the allowance

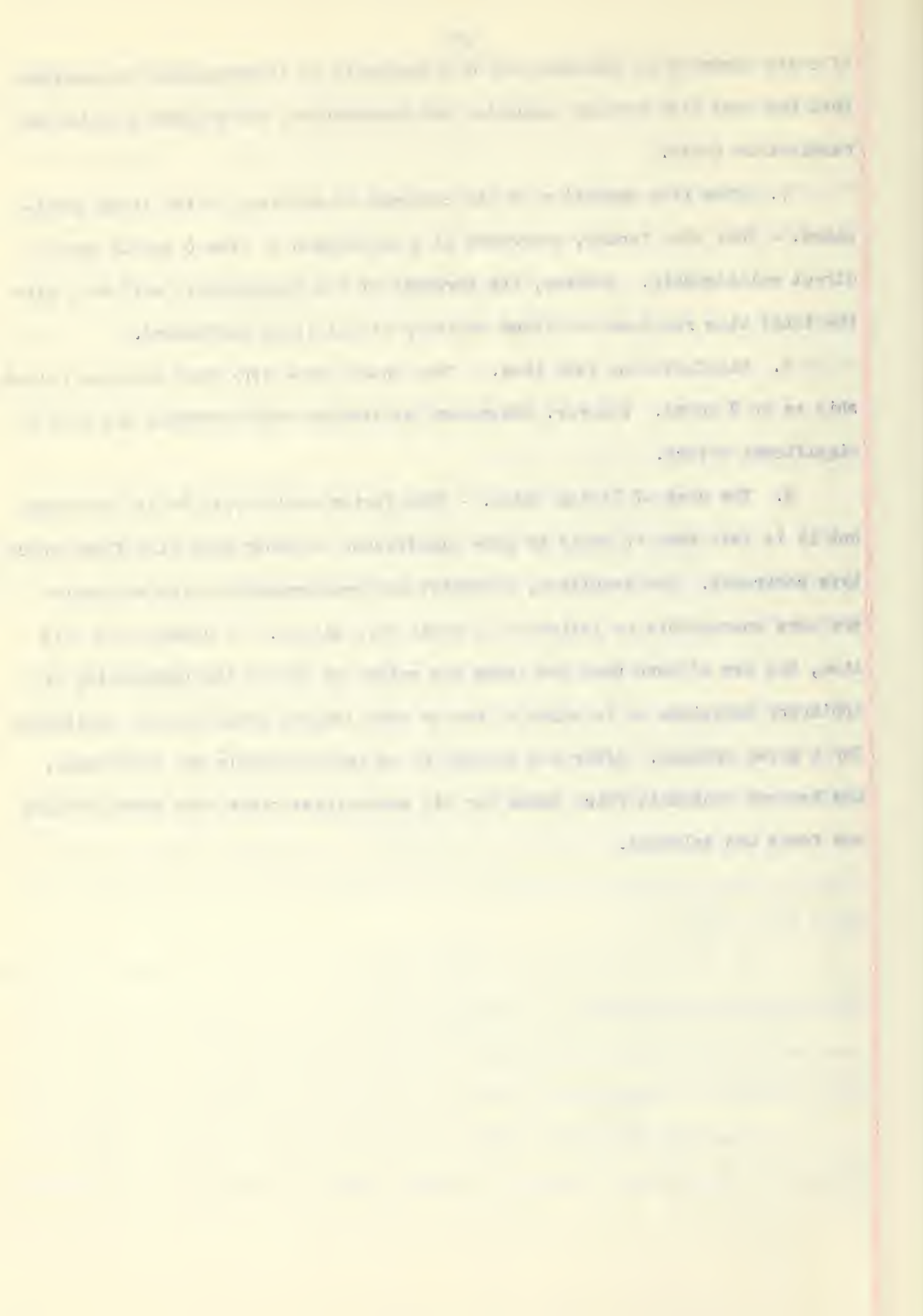


of costs incurred in anticipation of a contract, it is reasonable to conclude that the less time between execution and termination, the smaller will be the termination costs.

7. Time from execution of the contract to delivery of the items terminated. - This time factor, expressed as a proportion of item 6 should show a direct relationship. However, the strength of the relationship will vary with the total time required to effect delivery of all items terminated.

8. Manufacturing lead time. - This should show very much the same relationship as in 7 above. However, subsequent deliveries would probably not have a significant effect.

9. The cost of living index. - This factor would apply to all contracts but it is felt that it would be more significant in other than firm fixed-price type contracts. The escalator, incentive and redeterminable type contracts are more susceptible to inflation by their very nature. In considering this item, the use of more than one index was ruled out due to the probability of arbitrary decisions as to which of two or more indexes would be most applicable for a given product. After due thought to an index suitable for this study, the Revised Wholesale Price Index for all commodities other than farm products and foods was selected.



CHAPTER IV

THE STUDY

The decision made as to the data which suggested the most promising results, a starting point was the next particular to be resolved. As in the earlier study, basic information was obtained from the Bureau of Aeronautics Quarterly Contract Termination Status Report, Nav Exos 3728-A. The report provides, among other termination statistics, a list of all termination settlements effected during the reporting quarter. Separate sections are given to settlements with cost and to those without cost.

During the period from 1 January 1955 through 31 December 1958, the period covered by this study, a total of 477 termination claims were settled. Because of combined settlements included in this figure, the actual number of settlement agreements executed is somewhat less. Except for these combined settlements, all settlements were within the limitations imposed earlier.

At the time the first data was collected, a decision was made to include combined settlements. They were subsequently dropped from consideration as a result of the problems arising from the allocation of settlement costs to the individual termination actions.

Given this total number of termination claims settled, a sampling procedure had to be devised. The quarterly reports might well be considered a cluster. However, to give a measure of validity to the assumption made with respect to regulations governing claims, to eliminate any potential seasonal or political variation, and to give cognizance to the extreme range in the contract price of the items terminated, the decision was made to group the data by the

contract price of the items terminated. The range for this figure was from \$1 to \$178.5 million. After study of the data available the grouping was arranged as shown in Table III.

TABLE III
GROUPING DATA

Group	Contract Price of Items Terminated	Number in Population	Number in Sample
A	0 - 5,000	82	25
B	5,001 - 25,000	97	29
C	25,001 - 100,000	73	22
D	100,001 - 1,000,000	97	29
E	1,000,001 - 25,000,000	99	30
F	Greater than - 25,000,001	29	9

In view of the fact that this study was exploratory in nature and, therefore, the exact availability of data unknown, an initial sample of 30% was taken with the knowledge that various types of data would not be available for all contracts in the sample. However, it was hoped that the final sample would still be of sufficient size if the final results were useful.

To obtain the sample indicated for each group, the contract price of items terminated was placed in inverse order of settlement. That is, within group A, settlements made during the quarter ending 31 December 1958 preceded those made during the quarter ending 30 September 1958, etc. Within each section of the quarterly reporting period, the settlements with cost preceded those without cost. Next, all settlements within a group were consecutively numbered. By

means of a table of random digits, the sample was then selected.¹

Collection of Data

In Chapter III nine items were pointed out as offering the best potential for having a significant relationship to settlement costs. It was also stated that these were selected for the availability of information. It was this latter point which precluded gathering these nine pieces of information on the sample selected. The information is in files currently maintained by the Bureau of Aeronautics or in records which have been retired. Some of the information could not be collected directly while others required a page by page review of contract files. The result is that complete data for the sample size indicated in Table III was collected only for settlement costs and the items listed below. The source of each item is also given.

1. The value of items terminated. - Primary source for this statistic was the quarterly report. The data obtained from this source was checked with information in the Records and Control Section.² Where discrepancies occurred, they were resolved in favor of the status report on the grounds that further investigation showed this source to be the more accurate.

2. Time from execution of the contract to the termination in question. - The status report gave the termination date of the contract. The date of the contract was obtained from the Records and Control Section. At the time this latter information was collected, the termination date was checked. Discrepancies were few and involved a few days in the cases noted, with the status report always being the earlier date. This difference may be accounted for by

¹ Rand Corporation, "A Million Random Digits with 100,000 Normal Deviates", Free Press, Glencoe, Ill., 1955, partially reproduced in Statistics, A New Approach, W. A. Wallis and H. V. Roberts, (Glencoe, Ill., Free Press, 1956), p. 631.

² Services Branch, Contracts Division, Bureau of Aeronautics.

the recording of the telegraphic notice date in the status report and the recording of either the telegraphic notice date or the letter date, the latter sometimes being dated after the telegraphic notice. The earlier date was selected in all cases of conflict. The intervening time between the two dates was recorded to the nearest month on the basis of twelve 30 day months in a year. This method introduced error but it is not considered to be significant.

3. The cost of living index. - The revised Wholesale Price Index for all commodities other than farm products and foods was obtained from the Bureau of Labor. This index provides information for each month for the years included in the study.

Substantial data was also collected on the following items:

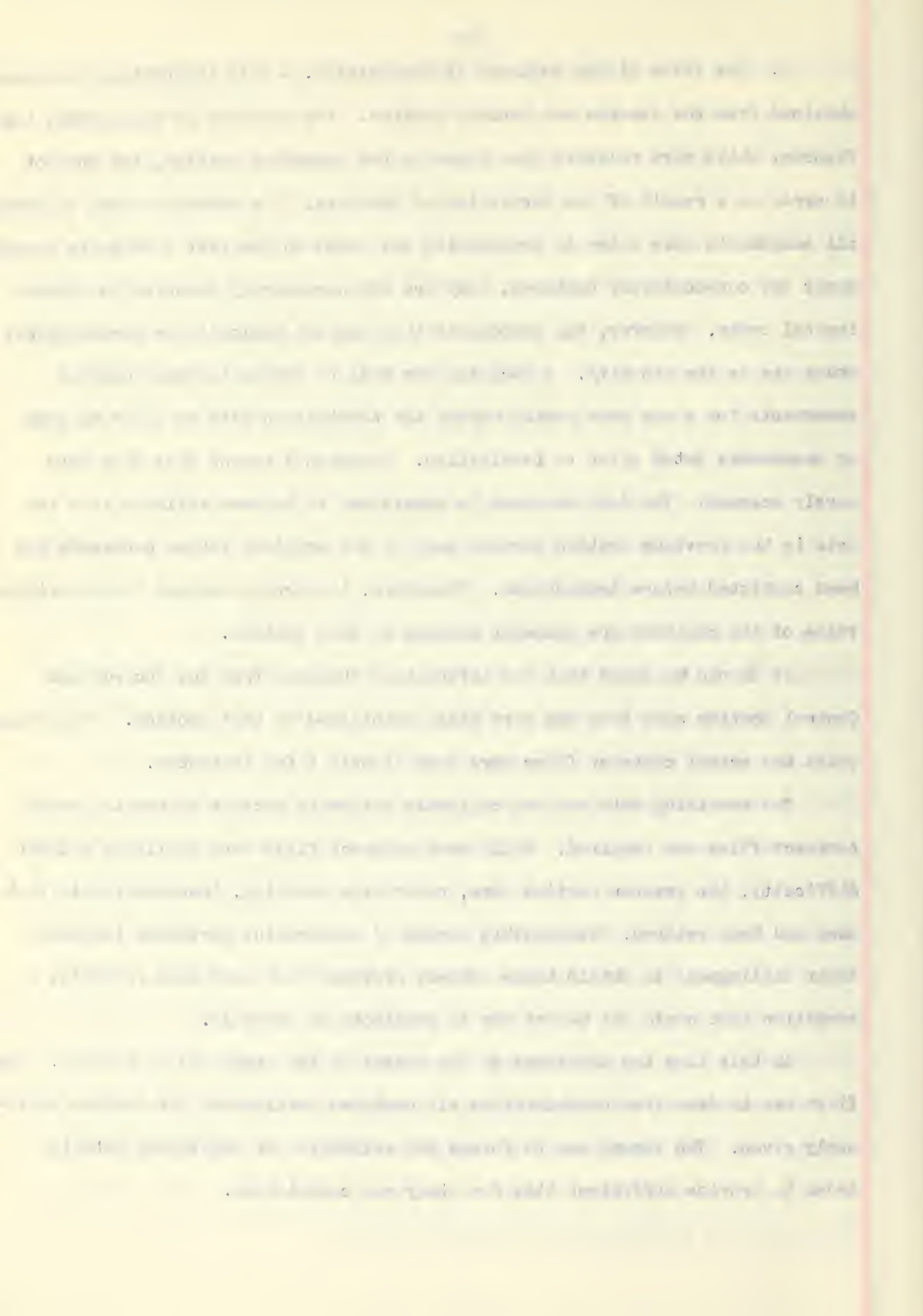
1. The original value of the contract. - The information collected came from the Records and Control Section. On contracts which were not originally letter contracts, no particular problems were met. The format of letter contracts does present problems in this area. In the first place, the contract has only a dollar limitation which cannot be exceeded. This generally has a bearing on the contract value contemplated but it is not the same figure. The best source of information for the original contract value contemplated is the so-called business clearance, a justification required by the Office of Naval Material before even the letter contract can be placed. There is a second problem with letter contracts after their conversion. As in the case with other contract types, the letter contract is subject to amendment. When the contract is converted to one of the fixed-price types, it normally includes all amendments. Thus, if the scope of a letter contract is increased by amendment and then converted, the value of the contract is shown as the amount originally contemplated plus the value added by the amendment. All of this has resulted in some very doubtful data. Time would not permit research in the business clearances for confirmation of the data obtained.

2. The value of the contract at termination. - This information was also obtained from the Records and Control Section. For purposes of this study, the figures, while more reliable than those in the preceding section, are subject to error as a result of the derivation of the data. The procedure used to cover all amendments date prior to termination was based on the fact that while amendments are consecutively numbered, they are not necessarily executed in chronological order. However, the amendments that are not basically in chronological order are in the minority. A decision was made to review the main body of amendments for a one year period beyond the termination date in order to pick up amendments dated prior to termination. Amendments beyond this date were merely scanned. The data obtained is considered to be more reliable than the data in the previous section because many of the original letter contracts had been converted before termination. Therefore, the errors evident in the original value of the contract are somewhat reduced in this section.

It should be noted that the information obtained from the Records and Control Section came from the card files maintained by that section. Up to this point the actual contract files were used in only a few instances.

The remaining data was not collected primarily because access to actual contract files was required. While some contract files were available without difficulty, the greater portion were, relatively speaking, inaccessible in that they had been retired. Responsible Bureau of Aeronautics personnel indicated their willingness to obtain these records provided they were used promptly, a condition that could not be met due to conflicts of schedule.

At this time two decisions on the extent of the study had to be made. The first was to drop from consideration all combined settlements for reasons previously given. The second was to forego the collection of additional data in order to provide sufficient time for study and computation.



CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

When this study was initiated a number of preliminary discussions were held with personnel from both the Office of Naval Material and the Bureau of Aeronautics. When the subject of the study was mentioned, the universal statement was to the effect that there are too many unrelated factors in each and every settlement to permit the application of statistical methods, however, a hope was expressed that an answer would be found. As will be seen, the opinions expressed were correct insofar as this study was concerned.

Conclusions

Insofar as the utilization of the data collected, the studies and computations made, there is very little to be said. The first step was to plot the various independent variables against the costs of settlement. The resulting charts gave little evidence of a significant correlation. Five representative charts are included in Appendix A.

At this point it became apparent that the study would not produce the desired result - a multivariate correlation of significance. However, certain computations were made on the independent variables for application in a linear correlation. The results are given in Table IV. Summary data used in the computations are given in Appendix B.

Of the nineteen linear correlations computed, only one was significant at a level of .01. One additional correlation coefficient was significant at a level of .05. The earlier study which considered the value of items terminated

CHAPTER I

THE HISTORY OF THE UNITED STATES

The history of the United States is a story of a people who have grown from a small colony of English settlers to a great nation of free men and women. The story begins in 1492 when Christopher Columbus discovered the New World. The first English settlers came to the United States in 1607, and the first American Revolution was fought in 1776. The United States has since grown to become one of the most powerful nations in the world.

CHAPTER II

The second chapter of the history of the United States is a story of a people who have grown from a small colony of English settlers to a great nation of free men and women. The story begins in 1492 when Christopher Columbus discovered the New World. The first English settlers came to the United States in 1607, and the first American Revolution was fought in 1776. The United States has since grown to become one of the most powerful nations in the world.

The third chapter of the history of the United States is a story of a people who have grown from a small colony of English settlers to a great nation of free men and women. The story begins in 1492 when Christopher Columbus discovered the New World. The first English settlers came to the United States in 1607, and the first American Revolution was fought in 1776. The United States has since grown to become one of the most powerful nations in the world.

The fourth chapter of the history of the United States is a story of a people who have grown from a small colony of English settlers to a great nation of free men and women. The story begins in 1492 when Christopher Columbus discovered the New World. The first English settlers came to the United States in 1607, and the first American Revolution was fought in 1776. The United States has since grown to become one of the most powerful nations in the world.

as the sole independent variable, and which did not group the data, gave a correlation of .581. This was significant at a level of .01. This is in sharp disagreement with the results of this study. As may be observed in Table IV, the greater the value of the items terminated, the better the correlation, although none were significant at a level of .05.

TABLE IV

LINEAR CORRELATION BY GROUPS FOR
CERTAIN INDEPENDENT VARIABLES

	Group					
	A	B	C	D	E	F
Value of items terminated	-.076	-.118	.032	.149	.222	.601
Time from execution to termination	.453 ^a	.365	.003	-.032	.258	-.209
Initial contract value	-.106	.099	.648 ^b	.103	--	--
Contract value at termination	-.093	-.098	.099	--	--	--

^aSignificant at a level of .05

^bSignificant at a level of .01

In general it may be said that the time from execution to termination is more important in the smaller terminations. The initial contract values used were based on doubtful information. The correlation for this item, although significant in one group, shows no basically useful information. The contract value at termination, as in the case of the other two correlations involving dollars, exhibits a trend to better correlation with a higher value of items terminated.

All computations are based on raw data obtained. The effect of application of a cost of living index to this data, under the proposed conditions, might provide better results, but it seems doubtful that they would be either significant or useful.

Now it becomes necessary to admit that under the conditions stated, the methods used and the data obtained, a statistical approach to the deobligation of funds in excess of estimated termination costs is not feasible. While this study was undertaken with a conviction that a solution would be found, it was also started with only a very basic knowledge of statistics. Herein may lie the primary cause for lack of positive results. Although the author is not familiar with the technical details, it seems reasonable to suppose that certain multivariate statistical methods might prove useful in a more advanced study of this problem. Such methods as factor analysis, discriminatory analysis and principal components have been fairly well developed in theory.

Recommendations

For the present, the problem of deobligating excess funds remains. Before the conclusion is reached that this problem is here to stay and that it must be lived with, two other roads should be investigated. The first, as indicated above, requires a more advanced knowledge of statistics. The second, while using the same level of statistics as in this study, would consider the problem at a higher level than the contract. Perhaps the key might be found in the appropriation level.

In this study no attempt was made to consider the various appropriations involved. If the funds in the various appropriations indicate a consistent percentage of the value obligated for terminated items showing up as the actual costs of settlement, and the deviation over a period of years is not significant, it is conceivable that a stock fund type operation might prove useful. In essence, the deobligation would then take place at the appropriation level rather than the contract level.

Such an operation might work as follows. A capital account of sufficient size would be established, perhaps on the basis of current backlog. At periodic intervals, not in excess of a year, each appropriation would transfer a given

amount to the stock fund. The amount to be transferred would be based on a percentage of the value of items terminated. All funds in excess of the amount transferred would be deobligated immediately and thus, available for additional procurement.

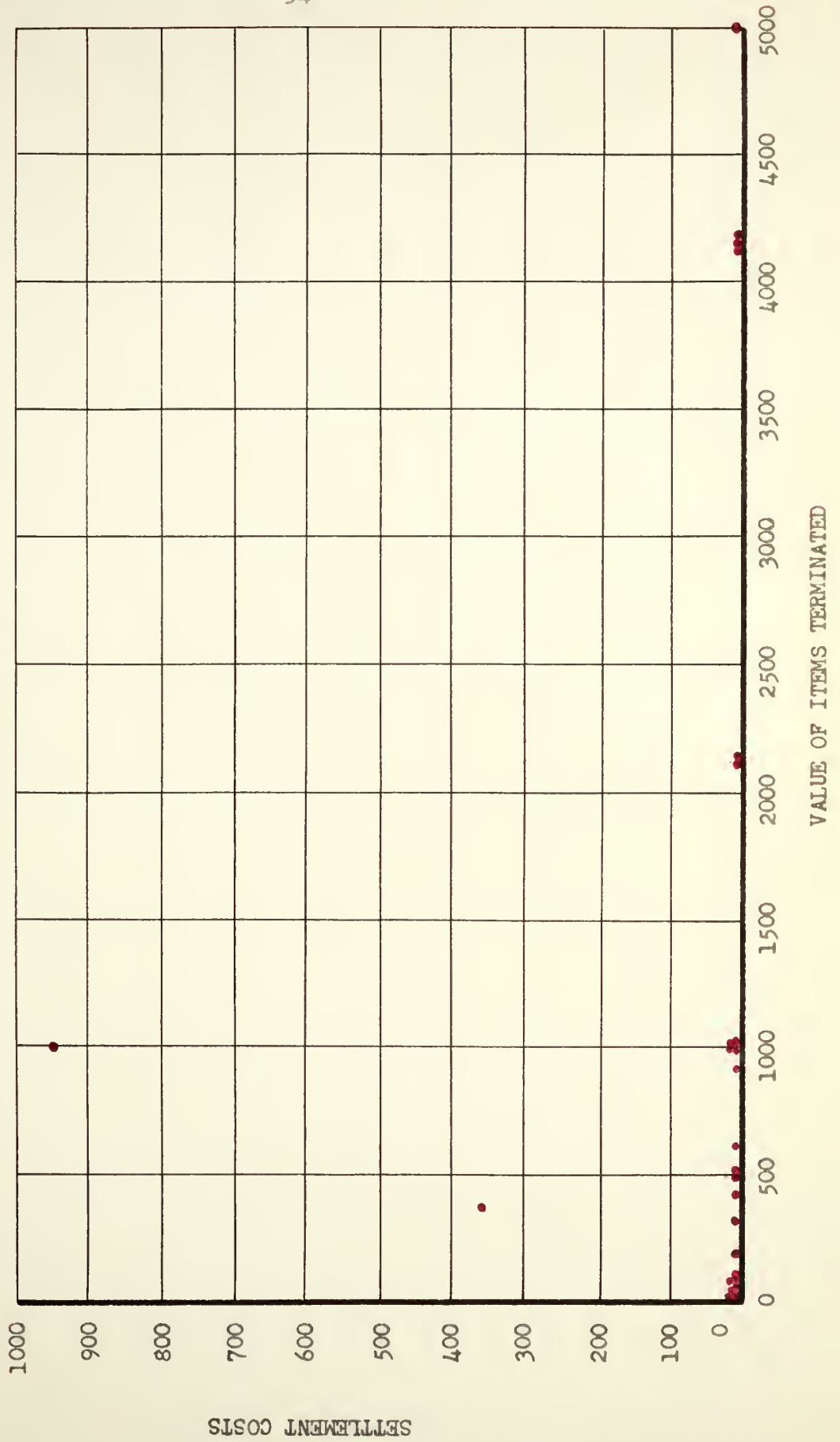
It is left to the reader to weigh the advantages and disadvantages of such an operation.

APPENDIX A

GRAPHS OF SELECTED DATA

The graphs on the following pages were selected for the following reasons. Graphs 1 and 3 were the only two which showed a significant statistical relationship. The three remaining graphs are considered to be representative of the other data collected. None of this latter group of graphs has a correlation which is significant at a level of .05.

Graph 1
Value of Items Terminated vs. Settlement Costs
Group A



1. done

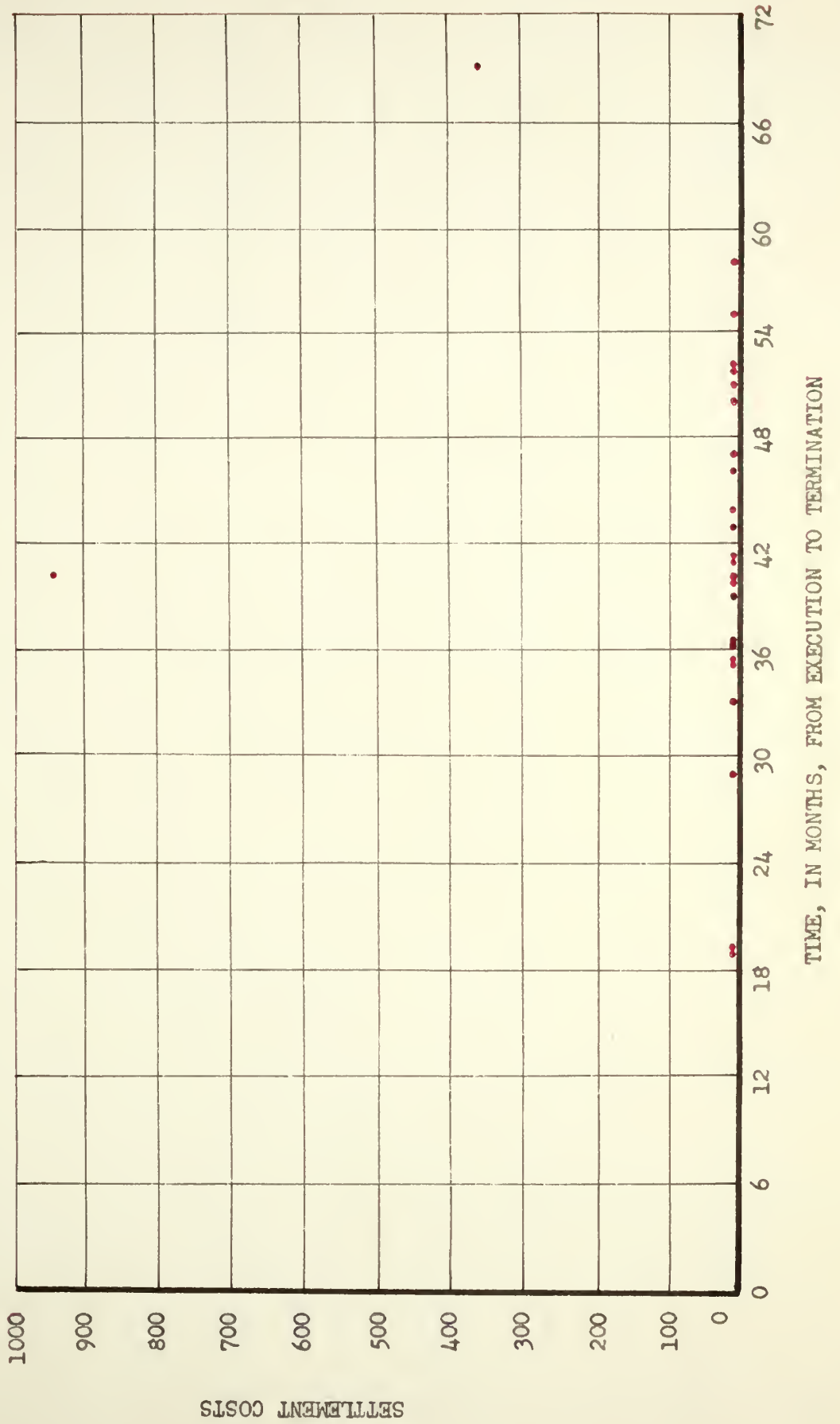
2. done

3. done



Graph 2
Time from Execution to Termination vs. Settlement Costs

Group A



5.10.10

Effect of temperature on the rate of reaction of sodium thiosulfate with hydrochloric acid

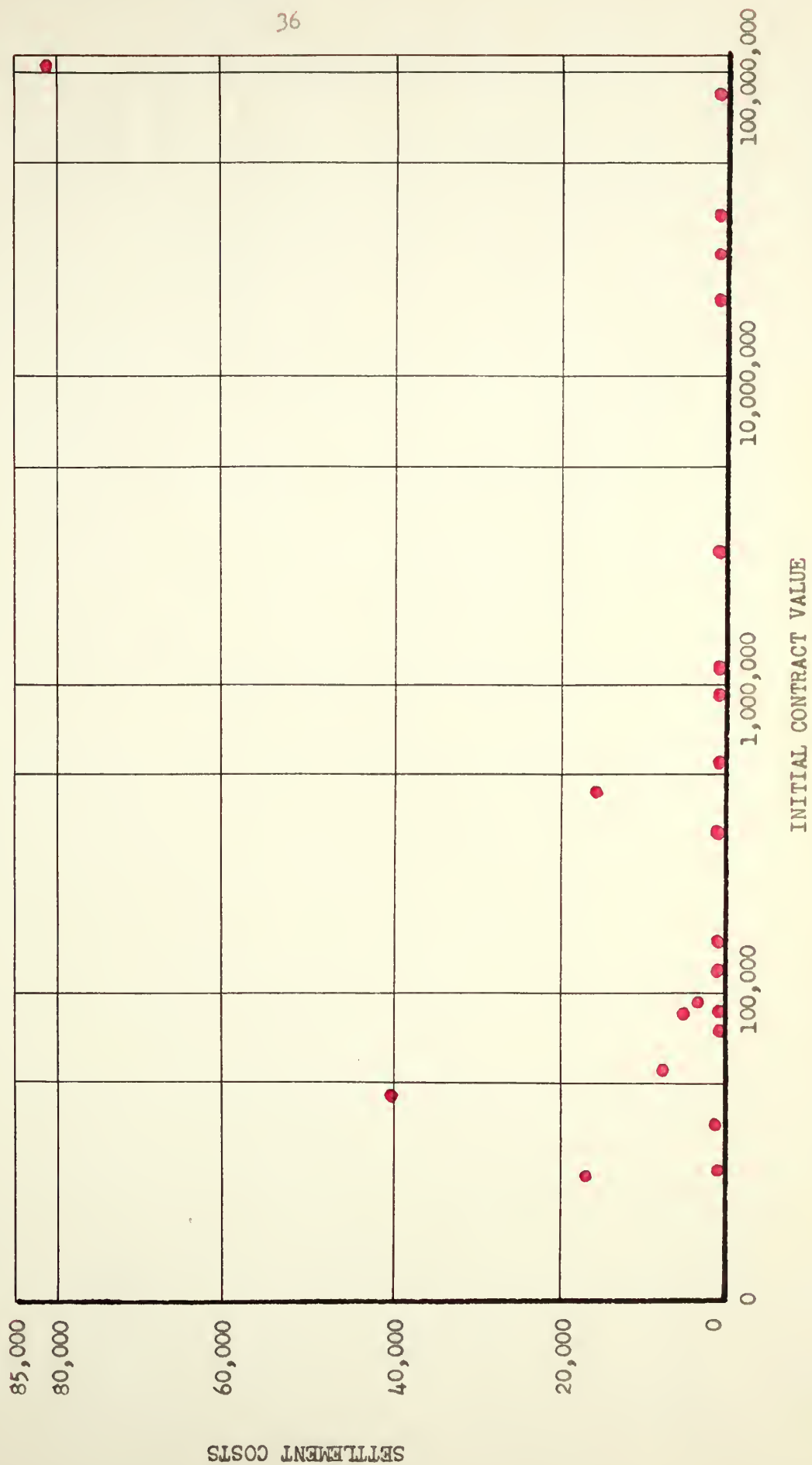
1. Aim



Graph showing the effect of temperature on the rate of reaction

Effect of temperature on the rate of reaction of sodium thiosulfate with hydrochloric acid

Graph 3
Initial Contract Value vs. Settlement Costs
Group C



Graph 4
Value of Items Terminated vs. Settlement Costs
Group F

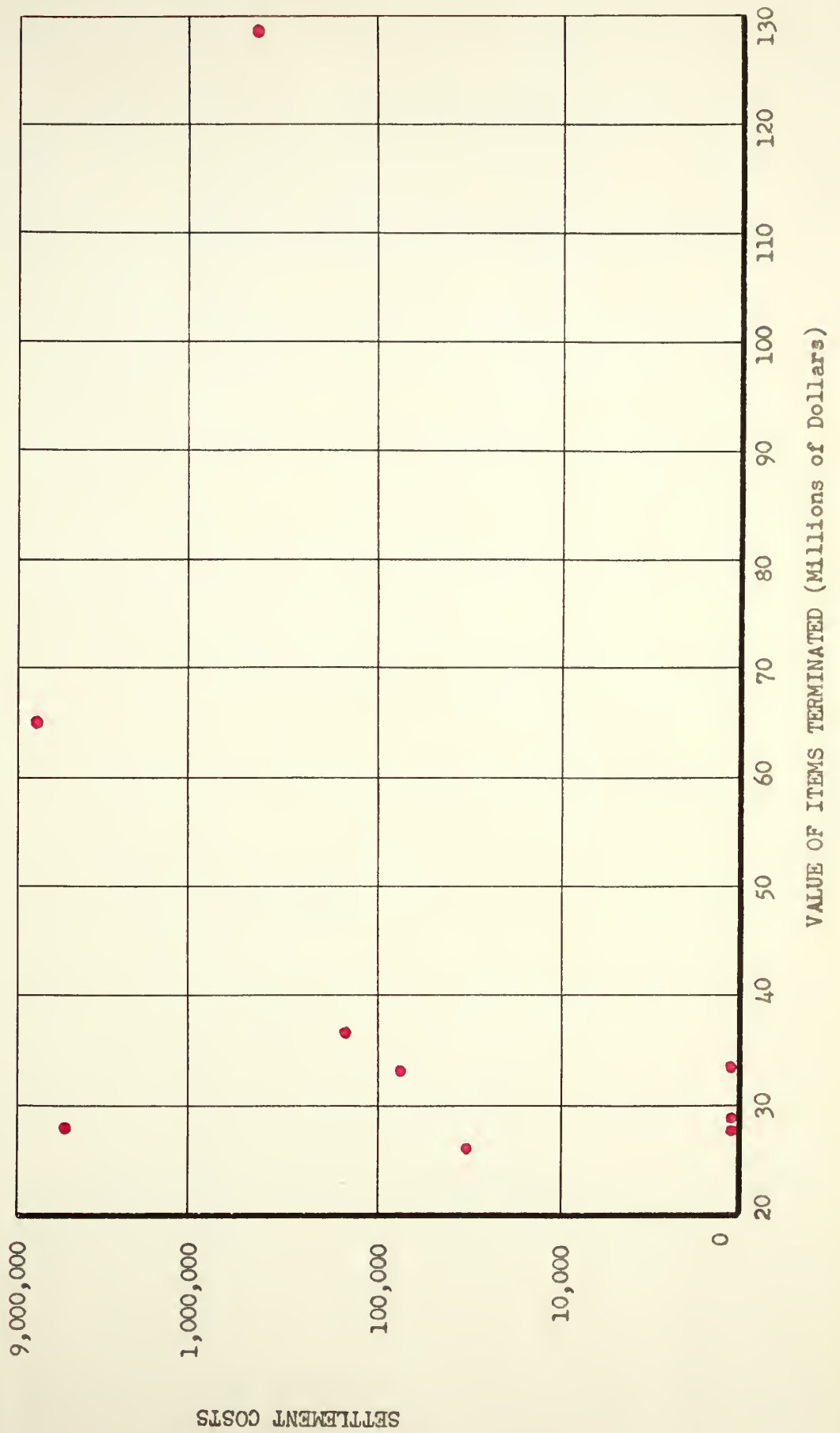


Figure 1

Relationship between \log_{10} of the number of bacteria and \log_{10} of the number of survivors

Figure 2

\log_{10} of the number of survivors

\log_{10} of the number of bacteria

Figure 3

\log_{10} of the number of survivors

Relationship between \log_{10} of the number of bacteria and \log_{10} of the number of survivors



Graph 5
Time from Execution to Termination vs. Settlement Costs
Group F

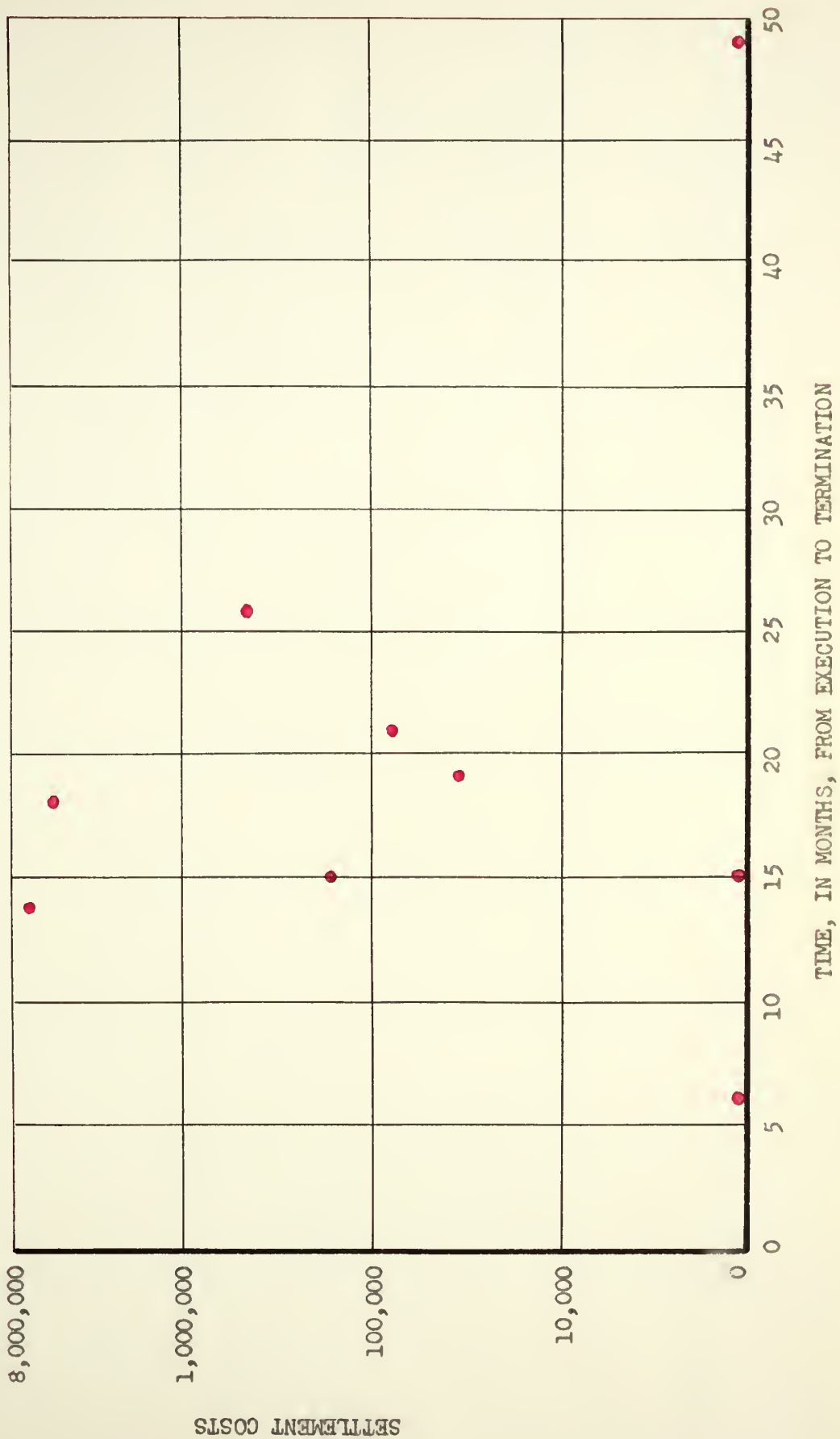


Figure 2
 The flow diagram of the proposed model



APPENDIX B

SUMMARY STATISTICAL DATA

The following pages are a summary of the data necessary for the computation of a linear correlation, the regression equation, and the standard error of estimate. Only the linear correlation coefficient has been computed.

Group A

X_1 - Value of items terminated

$$\sum X_1 = 3.151 \times 10^4$$

$$(\sum X_1)^2 = 9.932 \times 10^8$$

$$\sum X_1^2 = 9.784 \times 10^7$$

$$\sum X_1 Y = 1.084 \times 10^6$$

$$\bar{X}_1 = 1.261 \times 10^3$$

$$r = -.076$$

X_2 - Time, in months, from execution to termination

$$\sum X_2 = 1.052 \times 10^3$$

$$(\sum X_2)^2 = 1.107 \times 10^6$$

$$\sum X_2^2 = 4.731 \times 10^4$$

$$\sum X_2 Y = 6.291 \times 10^4$$

$$\bar{X}_2 = 4.208 \times 10^1$$

$$r = .453$$

X_3 - Initial contract value

$$\sum X_3 = 2.331 \times 10^7$$

$$(\sum X_3)^2 = 5.434 \times 10^{14}$$

$$\sum X_3^2 = 1.304 \times 10^{14}$$

$$\sum X_3 Y = 1.388 \times 10^8$$

$$\bar{X}_3 = 9.324 \times 10^5$$

$$r = -.106$$

X_4 - Contract value at termination

$$\sum X_4 = 2.513 \times 10^7$$

$$(\sum X_4)^2 = 6.314 \times 10^{14}$$

$$\sum X_4^2 = 1.289 \times 10^{14}$$

$$\sum X_4 Y = 3.850 \times 10^8$$

$$\bar{X}_4 = 1.005 \times 10^6$$

$$r = -.093$$

Y - Settlement costs

$$\sum Y = 1.311 \times 10^3$$

$$(\sum Y)^2 = 1.719 \times 10^6$$

$$\sum Y^2 = 1.033 \times 10^6$$

$$\bar{Y} = 5.244 \times 10^1$$

n - Sample size

$$n = 25$$

1888-1889 (1888-1889) = 1888

$$1888 = 1888 + 1888 = 3776$$

$$1888 = 1888 + 1888 = 3776$$

$$1888 = 1888 + 1888 = 3776$$

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1888-1889 (1888-1889) = 1888

$$1888 = 1888 + 1888 = 3776$$

Group B

X_1 - Value of items terminated

$$\Sigma X_1 = 3.773 \times 10^5$$

$$(\Sigma X_1)^2 = 1.424 \times 10^{11}$$

$$\Sigma X_1^2 = 5.766 \times 10^9$$

$$\Sigma X_1 Y = 9.725 \times 10^7$$

$$\bar{X}_1 = 1.301 \times 10^4$$

$$r = -.118$$

X_2 - Time, in months, from execution to termination

$$\Sigma X_2 = 7.810 \times 10^1$$

$$(\Sigma X_2)^2 = 6.100 \times 10^5$$

$$\Sigma X_2^2 = 3.241 \times 10^4$$

$$\Sigma X_2 Y = 2.159 \times 10^5$$

$$\bar{X}_2 = 2.693 \times 10^1$$

$$r = .365$$

X_3 - Initial contract value

$$\Sigma X_3 = 6.527 \times 10^7$$

$$(\Sigma X_3)^2 = 4.260 \times 10^{15}$$

$$\Sigma X_3^2 = 1.016 \times 10^{15}$$

$$\Sigma X_3 Y = 4.984 \times 10^9$$

$$\bar{X}_3 = 2.251 \times 10^6$$

$$r = -.099$$

X_4 - Contract value at termination

$$\Sigma X_4 = 7.983 \times 10^7$$

$$(\Sigma X_4)^2 = 6.373 \times 10^{15}$$

$$\Sigma X_4^2 = 1.460 \times 10^{15}$$

$$\Sigma X_4 Y = 6.647 \times 10^9$$

$$\bar{X}_4 = 2.753 \times 10^6$$

$$r = -.098$$

Y - Settlement costs

$$\Sigma Y = 8.824 \times 10^3$$

$$(\Sigma Y)^2 = 7.786 \times 10^7$$

$$\Sigma Y^2 = 2.861 \times 10^7$$

$$\bar{Y} = 3.043 \times 10^2$$

n - Sample size

$$n = 29$$

1. $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$$

$$[\text{H}_3\text{O}^+] = [\text{OH}^-] = 10^{-7}$$

$$\text{pH} = 7$$

$$[\text{H}_2\text{O}] = 55.5$$

$$[\text{H}_2\text{O}] = 55.5$$

$$[\text{H}_2\text{O}] = 55.5$$

2. $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$$

$$[\text{H}_3\text{O}^+] = [\text{OH}^-] = 10^{-7}$$

$$\text{pH} = 7$$

$$[\text{H}_2\text{O}] = 55.5$$

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$$[\text{H}_2\text{O}] = 55.5$$

3. $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$$

$$[\text{H}_3\text{O}^+] = [\text{OH}^-] = 10^{-7}$$

$$\text{pH} = 7$$

$$[\text{H}_2\text{O}] = 55.5$$

$$[\text{H}_2\text{O}] = 55.5$$

$$[\text{H}_2\text{O}] = 55.5$$

4. $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$$

$$[\text{H}_3\text{O}^+] = [\text{OH}^-] = 10^{-7}$$

$$\text{pH} = 7$$

$$[\text{H}_2\text{O}] = 55.5$$

$$[\text{H}_2\text{O}] = 55.5$$

$$[\text{H}_2\text{O}] = 55.5$$

5. $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$$

$$[\text{H}_3\text{O}^+] = [\text{OH}^-] = 10^{-7}$$

6. $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

$$K_w = 10^{-14}$$

Group C

X_1 - Value of items terminated

$$\Sigma X_1 = 1.401 \times 10^6$$

$$(\Sigma X_1)^2 = 1.963 \times 10^{12}$$

$$\Sigma X_1^2 = 9.635 \times 10^{10}$$

$$\Sigma X_1 Y = 1.203 \times 10^{10}$$

$$\bar{X}_1 = 6.368 \times 10^4$$

$$r = .032$$

X_2 - Time, in months, from execution to termination

$$\Sigma X_2 = 6.360 \times 10^2$$

$$(\Sigma X_2)^2 = 4.045 \times 10^5$$

$$\Sigma X_2^2 = 2.560 \times 10^4$$

$$\Sigma X_2 Y = 5.582 \times 10^6$$

$$\bar{X}_2 = 2.891 \times 10^1$$

$$r = .003$$

X_3 - Initial contract value

$$\Sigma X_3 = 2.690 \times 10^8$$

$$(\Sigma X_3)^2 = 7.234 \times 10^{16}$$

$$\Sigma X_3^2 = 1.942 \times 10^{16}$$

$$\Sigma X_3 Y = 9.402 \times 10^{12}$$

$$\bar{X}_3 = 1.223 \times 10^7$$

$$r = .648$$

X_4 - Contract value at termination

$$\Sigma X_4 = 2.971 \times 10^8$$

$$(\Sigma X_4)^2 = 8.824 \times 10^{16}$$

$$\Sigma X_4^2 = 6.587 \times 10^{17}$$

$$\Sigma X_4 Y = 9.476 \times 10^{12}$$

$$\bar{X}_4 = 1.350 \times 10^7$$

$$r = .099$$

Y - Settlement costs

$$\Sigma Y = 1.852 \times 10^5$$

$$(\Sigma Y)^2 = 3.429 \times 10^{10}$$

$$\Sigma Y^2 = 9.078 \times 10^9$$

$$\bar{Y} = 8.417 \times 10^3$$

n - Sample size

$$n = 22$$

Group D

X_1 - Value of items terminated

$$\Sigma X_1 = 1.033 \times 10^7$$

$$(\Sigma X_1)^2 = 1.068 \times 10^{14}$$

$$\Sigma X_1^2 = 4.558 \times 10^{12}$$

$$\Sigma X_1 Y = 5.124 \times 10^{11}$$

$$\bar{X}_1 = 3.564 \times 10^5$$

$$r = .149$$

X_2 - Time, in months, from execution to termination

$$\Sigma X_2 = 5.280 \times 10^2$$

$$(\Sigma X_2)^2 = 2.788 \times 10^5$$

$$\Sigma X_2^2 = 1.504 \times 10^4$$

$$\Sigma X_2 Y = 2.318 \times 10^7$$

$$\bar{X}_2 = 1.821 \times 10^1$$

$$r = -.032$$

X_3 - Initial contract value

$$\Sigma X_3 = 7.648 \times 10^8$$

$$(\Sigma X_3)^2 = 5.849 \times 10^{17}$$

$$\Sigma X_3^2 = 1.140 \times 10^{17}$$

$$\Sigma X_3 Y = 4.473 \times 10^{13}$$

$$\bar{X}_3 = 2.637 \times 10^7$$

$$r = .103$$

Y - Settlement costs

$$\Sigma Y = 1.314 \times 10^6$$

$$(\Sigma Y)^2 = 1.728 \times 10^{12}$$

$$\Sigma Y^2 = 1.611 \times 10^{11}$$

$$\bar{Y} = 4.532 \times 10^4$$

n - Sample size

$$n = 29$$

Group E

X_1 - Value of items terminated

$$\Sigma X_1 = 1.486 \times 10^8$$

$$(\Sigma X_1)^2 = 2.207 \times 10^{16}$$

$$\Sigma X_1^2 = 1.591 \times 10^{15}$$

$$\Sigma X_1 Y = 1.515 \times 10^{14}$$

$$\bar{X}_1 = 4.952 \times 10^6$$

$$r = .222$$

X_2 - Time, in months, from execution to termination

$$\Sigma X_2 = 6.720 \times 10^2$$

$$(\Sigma X_2)^2 = 4.516 \times 10^5$$

$$\Sigma X_2^2 = 2.475 \times 10^4$$

$$\Sigma X_2 Y = 6.777 \times 10^8$$

$$\bar{X}_2 = 2.240 \times 10^1$$

$$r = .258$$

Y - Settlement costs

$$\Sigma Y = 1.738 \times 10^7$$

$$(\Sigma Y)^2 = 3.022 \times 10^{14}$$

$$\Sigma Y^2 = 1.108 \times 10^{14}$$

$$\bar{Y} = 5.794 \times 10^5$$

n - sample size

$$n = 30$$

Group F

X_1 - Value of items terminated

$$\Sigma X_1 = 4.058 \times 10^8$$

$$(\Sigma X_1)^2 = 1.647 \times 10^{17}$$

$$\Sigma X_1^2 = 2.674 \times 10^{16}$$

$$\Sigma X_1 Y = 6.380 \times 10^{14}$$

$$\bar{X}_1 = 4.509 \times 10^7$$

$$r = .601$$

X_2 - Time, in months, from execution to termination

$$\Sigma X_2 = 1.830 \times 10^2$$

$$(\Sigma X_2)^2 = 3.349 \times 10^4$$

$$\Sigma X_2^2 = 4.885 \times 10^3$$

$$\Sigma X_2 Y = 1.987 \times 10^8$$

$$\bar{X}_2 = 2.033 \times 10^1$$

$$r = -.209$$

Y - Settlement costs

$$\Sigma Y = 1.231 \times 10^7$$

$$(\Sigma Y)^2 = 1.514 \times 10^{14}$$

$$\Sigma Y^2 = 6.831 \times 10^{13}$$

$$\bar{Y} = 1.367 \times 10^6$$

n - Sample size

$$n = 9$$

Example 1: Let $f(x) = x^2$

$$f'(x) = 2x \Rightarrow f'(1) = 2$$

$$f(1) = 1 \Rightarrow f(1) = 1$$

$$f(1) \times f'(1) = 2$$

Example 2: Let $f(x) = x^3$

$$f'(x) = 3x^2 \Rightarrow f'(1) = 3$$

$$f(1) = 1 \Rightarrow f(1) = 1$$

$$f(1) \times f'(1) = 3$$

Example 3: Let $f(x) = x^4$

$$f'(x) = 4x^3 \Rightarrow f'(1) = 4$$

$$f(1) = 1 \Rightarrow f(1) = 1$$

Example 4: Let $f(x) = x^5$

$$f'(x) = 5x^4 \Rightarrow f'(1) = 5$$

$$f(1) = 1 \Rightarrow f(1) = 1$$

$$f(1) \times f'(1) = 5$$

$$f(1) \times f'(1) = 5$$

$$f(1) = 1 \Rightarrow f(1) = 1$$

$$f(1) \times f'(1) = 4$$

$$f(1) \times f'(1) = 4$$

$$f(1) = 1 \Rightarrow f(1) = 1$$

$$f(1) \times f'(1) = 3$$

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